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MATHEMATICAL WRITING OF INTERMEDIATE SCHOOL'S LEVEL THREE FEMALE STUDENTS IN RIYADH CITY AND ITS RELATION WITH MATHEMATICAL THINKING

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Abstract

Purpose of the Study: The study sought to discover the level of mathematical thinking in mathematical writing among the female students of the intermediate third-level in Riyadh, and thus determine the relationship between the levels of mathematical writing and mathematical thinking among the female intermediate students of the third level.

Methodology: In this research, the descriptive and analytical method is used. The analytical descriptive method was used to analyze 68 books of mathematics textbooks. The study tools consist of the mathematical writing analysis card for the records of the students and to measure their mathematical thinking.

Main Findings: The development of mathematical thinking in mathematics education is the main domain of this research. Through the paper, the researcher explains the students' mistakes in their mathematical writing.

Applications of this study: The results of this study may serve to guide teachers to take care of student writing, the importance of providing a track record for students' writing and their training in the integrity of mathematical writing, showing them understanding and teaching them to provide appropriate learning.

Novelty/Originality of this Study: In light of the results of the study, the researcher suggests conducting studies such as: determining the relationship between the level of mathematical writing among students and other variables such as achievement, mental ability and problem-solving. The study may also be conducted on the relationship between the teaching practices of the mathematics teachers in the mathematical communication between the students and the construction of a training program to develop the written communication among the students.

Keywords: *Mathematical Writing, Mathematical thinking, Intermediate school, Mathematical Communication, Mathematical concept, students' performance.*

INTRODUCTION

Mathematics is characterized by a special language with symbols, terminology, and accurate and concise representations. It is a special language because the symbols and abbreviation it uses are universal throughout the world. It is obvious that learners and should aware of their true and real meaning so that they can achieve their learning goals.

The study aims at revealing the level of mathematical writing by the intermediate school's level three female students in Riyadh in their records book and their relation to the level of mathematical thinking they have. The researcher applied this research to 68 students. The paper explains the students' mistakes in their writing. The results of the study shows that the level of mathematical writing among female students is low in most of its components or elements such as: "describing and interpreting relationships and ideas in the correct mathematical language"; "justification and criticism of answers"; "clarifying mathematical generalizations when solving mathematical issues"; "clarify errors in the solution and write the required correction". The study emphasizes the importance of using the records of the students to analyze their writings and to verify their ability in mathematical writing, and to train them in writing step by step, with the explanation and justification of their own conclusions, to develop their mathematical thinking.

The National Council of Mathematics Teachers of the United States of America confirmed the importance of achieving various goals by the teachers of Mathematics (NCTM, 2000). The aim of learning mathematics is to develop mathematical thinking and to consider mathematics as an important means or tools of exchanging ideas clearly and accurately through mathematical communication, and in their written documents (NCTM, 2000, 2014). It stressed the importance of the use of learners' written communication to express themselves in a more visible and interdependent way.

The Common Core State Practice Standards have also followed the interest in mathematical writing since its beginnings (CCSSM, 2010), emphasizing the importance of learners being able to communicate accurately with others, by explaining how to solve problems, using clear definitions and vocabulary, and building viable arguments of the application, enables them to critique the mathematical thinking of others.

Studies have shown that writing in math classes when used as a learning tool has provided learners with opportunities to reflect on the concepts they learn and enhance their mathematical thinking with a deeper understanding of problems and contributed in organizing and refining ideas and troubleshooting concepts and to improve the ability of learners to communicate mathematically with others. (Thompson, 2010). It is obvious using writing in the classroom as a tool of learning makes student confidence and gives a chance to enforce mathematical thinking so that to understand Maths problem deeply. It discovers mistakes and improves the ability of the learner to explain the mathematical idea with others.

Studies that have focused on analyzing the writings of students to check for the type and depth of the writing and it is found that most of the students' writings were copying or redrafting rather than explaining new ideas, geared towards explaining how they used to solve the problem. Most of the justifications and examples provided by students were incorrect or incomplete. The conceptual learning opportunities and exploration of mathematical processes and thinking are few, and they recommended the importance of writing in the classroom. (Pugalee, 2004; Meletiou-Mavrotheris&Paparistodemou, 2015).

Despite the importance of writing and its impact on many of the areas of mathematics education, various studies have been demonstrated writing as an important learning tool, but there are a few studies concerned with the use and importance of writing used in mathematics education (Fried&Amit, 2003; Ediger, 2006; Casa, et al, 2016).

The Problem of Research

Although the development of mathematical thinking is the main objective of mathematics education, which all elements of the educational process seek to achieve, using the study of international trends in science and mathematics (TIMSS, 2003, 2007, 2011, 2015). The results of the national tests for the year 1435/1436 H, announced by the Education Assessment Board (2016) in the Kingdom of Saudi Arabia, indicates a general weakness in the performance of learners in mathematics, indicating that this goal has not been achieved.

The mathematics curriculum in Saudi Arabia was built in the light of the school mathematics principles and standards in the National Council of Mathematics Teachers. Mathematical communication is one of the criteria for its operations. In all stages of public education, Mathematics requires various higher-order thinking skills such as: Interpretation of guesswork and critique of argument and representation, or description or explanation process. That is why it is obvious to develop written skills in Mathematics

However, what the researcher observed from some of the classroom observations and the training programs for the mathematics teachers is the non-seriousness of teachers in the follow-up of their female students. The teachers are not serious about the notebook or records of the students. Moreover, there are few teachers who use small posters to solve the exercises, indicate the need to highlight the level of mathematical writing in the classroom throughout the year in the third level intermediate female students in their records and their relation to the level of mathematical thinking they have.

In light of the above, the main questions of the study are: What is the level of mathematical writing in the records of students of the third grade average in the city of Riyadh and how it relates to the level of mathematical thinking they have?

The following questions are divided:

Question 1: What is the level of mathematical writing in the records of third-level intermediate female students in Riyadh?

Question 2: What is the level of mathematical thinking among the third-level intermediate female students in Riyadh?

Question 3: Is there a statistically significant relationship between the level of mathematical writing in the records of third-level intermediate female students and their average level of mathematical thinking?

LITERATURE REVIEW

NCTM (2000) emphasized the need to provide mathematics as a tool for thinking and communication that helps learners to make them becoming thinkers and emphasized the teaching of reasoning, reasoning, and problem-solving and helps them to develop.

The American National Commission for the Advancement of Science has classified mathematical thinking into two levels where the low level of thinking includes observing, measuring, predicting, classifying, summarizing, and compiling information. High-level thinking includes interpretation of data, control of variables, the imposition of hypotheses and experimentation (Ibrahim, 2005).

Despite the importance of mathematical thinking, the studies indicated that there was a weakness in the level of mathematical thinking among students. A study of Al Hashimi (2010) revealed a low level of mathematical thinking among a sample of students in basic grades (3-6) in the Sultanate of Oman. However, Star(2018) revealed a positive correlation between the level of mathematical thinking and achievement in a sample of selected tenth-grade students in Jordan, where the study showed that the level of mathematical thinking is average.

The National Council of Teachers of Mathematics emphasized the need to provide learning opportunities that allow learners to explain and clarify their understanding, and considered mathematical communication a powerful tool for this (NCTM, 2000). It emphasized written communication as one of the most important elements for developing mathematical understanding among learners. Pugalee (2004) argues that when learners write in their own way and in their own words, this writing can improve mathematical understanding by providing information about their way of thinking. Written interpretations reveal their deep understanding and the quality of their connection to ideas (Van de Walle, 2007), and Pugalee (2005) explains that data interpretation requires a learner to write about a variety of subjects, such as presenting examples of a particular concept or procedure, and explaining calculations to solve the problem, which encourages them to think as they learn.

Flores (2006) argues that the practice of justification in class helps learners remember what they have learned by highlighting the important ideas in the lesson, and the concepts around them. Thus, a teacher should follow the students from the beginning. In the beginning, the students will commit mistake but will improve later.

Pugalee (2015) argues that clear writing should include comparative tasks; description: which is intended to provide details using key terms, diagrams; explanation, which explains solutions, steps, ideas, concepts and guesses using numbers, symbols, drawings, and examples; (Such as mathematical information from spreadsheets, diagrams, graphs, models, and symbolic representations); and to provide reasoning or justification: intended to provide supporting evidence for thinking including examples, mathematical concepts and definitions, theories, and other reasons that support the rule; and display all the works: and where are all the calculations and the steps and ideas that the thought of the students included.

There are many and varied classifications of mathematical writing tasks. Some of them believe that mathematical writing has the first levels of recording and summarizing, in which learners record information focused on the facts and definitions of procedures and summaries according to the teacher's directions, describing realistic examples in their own words (Baxter, Woodward & Olson, 2005; Cohen et al, 2015). Among the four types of writing: exploratory writing, interpretive writing, dialectical writing, and creative mathematical writing (Casa, et al., 2016) emphasized the need for teachers to use mathematical writing to help students communicate in mathematics and to learn mathematics while allowing students to practice all kinds of mathematical writing. This is also confirmed by Thompson (Thompson, 2010) that it helps teachers develop mathematical concepts and to modify erroneously; to organize thinking, to communicate mathematical ideas, and to develop mathematical thinking with a deeper and richer understanding of mathematics, which requires extended classroom experience (Atieri, 2010).

Therefore, the studies focused on analyzing students' writings to verify the type and depth of academic writing. They used several tools. Some of them were interested in analyzing students' writings in their daily records to reveal the depth of mathematical writing as Fried & Amit (2003) found that the writings of students in the books in general, and does not contain any exploratory work, wrong beginnings or alternative strategies, or rephrasing, and believes that the lack of a special area of learning in the book reduces the student's ability to recognize the mathematical ideas, which he considers points that require of analysis and thus recommended books should be used on the necessity and the consciousness of the students.

In a study, Evens & Houssart (2004) analyzed the answers of more than 400 answers of11year-old learners on a mathematical question requiring them to determine the validity of the answer with justification and a written explanation of their judgment. The results showed that learners had an understanding of mathematical information but lacked the ability to provide adequate explanations, which is observed through their writings. Another study by Hamada (2006) and Mehdi et al. (2009) has analyzed the responses of eighth-grade students using a scale to measure the level of mathematical communication. The two studies have shown a common weakness in the ability of learners to explain ideas in mathematical language, in addition to the weakness in the writing of the meanings of figures and symbols.

Studies have shown that mathematical writing is a tool in remedial programs to support mathematical communication among learners and as a communication tool between learners and teachers (Kostos& Shin, 2010; Santos &Semana, 2015).

Writing requires a sufficient amount of writing space, so there must be a record of writing used by the student. This helps them to build their knowledge and assess their understanding to be meaningful to them. This is confirmed by studies on the importance of writing in journals. The resources used to integrate writing in mathematics classes to enable learners to use the correct mathematical vocabulary and to see the relationship between the concepts and terms they know while learning new mathematical vocabulary. It enables them to build mathematical knowledge in their own language, study relationships with other components to summarize ideas, experiences, and opinions before and after instruction (Tuttle, 2005; Kelly, 2008).

METHODOLOGY

In this research, the descriptive and analytical method is used. The descriptive approach was used to determine the level of mathematical thinking among the sample students. The analytical descriptive method was used to analyze 68 books of mathematics textbooks. The second semester of the year H1439 is used for study as a sample. Most students use their books as a writing record as the main reference for learning, which is followed by the teacher.

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The sample of the study was randomly chosen. Seven schools were randomly selected and one school was chosen from each office: '21 West Office, 36 South Office, 74 Al Budayah Office, 91 Office of Al Nahda, 84 Al Ruabi Office, 98 Al Shifa Office and the Office of Al-Shua' were selected in a random manner and tested by its students in the Mathematical Thinking Scale on 9/8/1439 H. On 25/8/1439 H, their books were received for analysis. Of each class, 9-10 students were randomly selected for the data study.

Population and Sample Study

The study population consisted of the third level female students in Riyadh in government schools, and mathematics books used for the third level of the year H 1439. The sample of the study was 68 students from the third level intermediate school.

Study Tools

Two data collection tools were constructed as follows:

(i) Preparing a mathematical writing card

The researcher prepared a card to measure the level of mathematical writing among the third-grade students in the standard writing record in the student's book. It is based on the results of the studies and researches that deal with the analysis of the students' mathematical writings. The following table is the presentation to a group of arbitrators from the curriculum and teaching methods:

Table 1: Elements of mathematical writing

SN	Elements of Mathematical Writing
1.	Writing or the representation of mathematical concepts and terminology used in the mathematical issues in terms or an example or graphics
2.	Description and interpretation of relationships and ideas contained in the mathematical issues, correct mathematical language (use of mathematical expressions and tables and graphics).
3.	Use appropriate cohesive words when solving mathematical issues
4.	Clarify the mathematical generalizations used, (rules) when solving mathematical issues.
5.	Justify or critique the answers with symbolic or analytical evidence, or counter examples when solving mathematical issues.
6.	Solve higher-order thinking issues
7.	Explain errors in the solution and its causes and write the correction required
8.	Using her own language (arrows, examples, keywords) : - Taking notes about mathematical concepts and procedures. - To distinguish the important points and study guidelines.
9.	Decoding ideas and procedures: through brochures - Schemes - include: - Classification and comparison of similar mathematical concepts and terms. - The most important laws and procedures used. - Writing notes for common mistakes.

The researcher conducted the following procedures to select the analysis unit:

Analysis of mathematical writing requirements according to the terms of the analysis card

due to the different writing requirements between the elements of the analysis card, the elements from 1to 5 are related to the main requirements in teaching the mathematical content. So, the students should train to understand the content and acquire the skill through exercises. The number 6 is related to issues of higher thinking skills in the student's book. The element 8 is concerned with the vocabulary and procedures of each lesson. The element 9 is one of the requirements stated in the book of the student in the introduction to each chapter.

Therefore, the researcher held a meeting with 40 teachers of Mathematics for Intermediate level, followed by multiple supervision and discussion, to inquire about the area on solving the students' difficulty. The researcher found that most of the teachers focus on solving all the solved exercises in the student's book. While the practice of special exercises to make sure they trained students to solve sums and the students are guided to do at least half exercises as homework to judge their mathematical thinking. Therefore, after the verification of the result of the survey, the researcher adopted the analysis unit as follows:

The Mathematical Writing Analysis Card for elements (1-5): The unit of analysis was calculated. There were 29 lessons in Mathematics book of the third level intermediate grade of the second semester. The analysis of students' writing was done for

each chapter. The tests were calculated as follows: all given questions; half the number of questions confirmed; one question for practice. A total of 520 questions were done as an exercise.

The Unit of Analysis for Element 6: Inculcating higher thinking skills was considered the most important factor in Mathematics. To achieve the goal the researcher concentrated on 3-6 exercises. The researcher selected one higher thinking question from each exercise of the third level book. This type of exercise will guide the students to develop thinking skills.

It was also revealed to the researcher that in the course of her meeting with the teachers, element 7, "clarifying the errors in the solution and its reasons and writing the required correction" was not sufficiently focused by the teachers. The unit of analysis was considered as follows: Of all the lessons of the book of mathematics in any exercise of the book, and the number of questions attempted is 29.

The unit of analysis for element 8 is the "use its own language (arrows, examples, keywords)": This element observes about mathematical concepts and procedures, highlights the important topic points, and supports in grasping important mathematical vocabulary. The numbers of questions attempted are 89.

The unit of analysis for element 9 of the student's summary was also calculated according to the requirement of preparing the leaflets; the students prepared 5 questions in each chapter.

Calculation of the stability and validity of the analysis card level of mathematical writing

The researcher, together with one of the supervisors, analyzed the first chapter of the mathematics book of the third level Intermediate class, in the light of the list of elements in the previous analysis. The following table shows the coefficients of stability and honesty.

Table 2: Coefficients of the stability and validity of the mathematical writing card

Indicators	Factor Stability in Holsti equation	Cronbach's alpha coefficient	Factor Self-honesty
1	0.92	0.778	0.882 **
2	0.95	0.724	0.851 **
3	0.96	0.769	0.877 **
4	0.94	0.756	0.869 **
5	0.90	0.723	0.850 **
6	0.91	0.798	0.893 **
7	0.93	0.804	0.897 **
8	0.90	0.794	0.891 **
9	1.00	0.796	0.892 **
Total	0.93	0.798	0.893 **

** D statistically at (0.01)

From the previous procedures, the validity and reliability of the analysis card are clear.

(ii) Preparing measures for mathematical thinking

In the light of the concept of mathematical thinking and its skills in the previous research and studies, the researcher prepared a measurement of mathematical thinking consisting of 10 questions, and the scale was presented to a group of specialists for judging and making the required modifications. The specialists removed 2 questions. In the light of their observations, (4, 6) have been considered as deduction, the skill of induction represented by questions (5, 7), and the skill of justification represented by questions (2, 8) and the skill of solving verbal or oral questions represented by questions (1, 3).

Measurement of validity, consistency, ease and discrimination measures of the mathematical thinking scale

The test was applied to a sample of 45 students in the third level Intermediate class. The coefficients of ease, difficulty, and discrimination were calculated as follow:

First: Calculate the ease and discrimination coefficients of the mathematical thinking scale questions

The following table illustrates the ease and difficulty factors and the identification of the questions of the mathematical thinking scale among the average third level students:

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Table 3: Ease and discrimination coefficients for the mathematical reasoning measures (n = 45)

Question number	Ease coefficient	Coefficient of discrimination
1	0.33	0.36
2	0.32	0.33
3	0.37	0.24
4	0.53	0.29
5	0.55	0.59
6	0.44	0.29
7	0.35	0.33
8	0.37	0.30
Total	0.41	0.34

It is clear from the above table that all ease and discrimination transactions are at an acceptable level.

Second: Calculating the stability and validity of the mathematical thinking scale

The reliability of the scale was calculated by calculating the correlation coefficient between the question score and the total score of the scale, like the rest of the scale questions.

Table 4: Reliability and Stability Parameters of Mathematical Thinking Scale (N = 45)

Question No	Cronbach Alpha coefficient	The coefficient of correlation of the degree of the question to the total degree of the test when deleting its grade from the total grade of the test
1	0.699	0.31 *
2	0.672	0.43 **
3	0.687	0.36 *
4	0.688	0.35 *
5	0.662	0.47 **
6	0.672	0.43 **
7	0.670	0.44 **
8	0.676	0.41 **
Total alpha coefficient of test (8 questions) = 0.707		

* D at (0.05) ** D at (0.01)

The following table shows the following:

The total stability coefficient of the mathematical thinking scale in the Cronbach alpha coefficient is high indicating the overall stability of the scale.

All correlation coefficients between the score of each question and the total score of the test (if the degree of question is deleted from the total score of the scale) are statistically significant at (0.01) or (0.05).

DISCUSSION / ANALYSIS

Question 1: What is the level of mathematical writing among the female students in the third level Intermediate in Riyadh?

To answer this question, calculate the ratio of female students according to the nine indicators presented in Table 1, using the test (T) of the sample to calculate the difference between the average student writing ratio and the value (0.50) which indicate 50% of the writing grade that the students are supposed to do.

Table 5: Mathematical Writing Ratio and Test Value (T) for Third Level Students

No.	The total enrollment of 68 students	Total mathematical writing with 68 students	Percentage of writing students in books	Value (T)

1	520 x 68	22510		0.637	6.98 **
2	520 x 68	26		0.001	1238.93 **
3	520 x 68	13454		0.380	6.34 **
4	520 x 68	1895		0.054	35.59 **
5	520 x 68	22		0.001	1282.15 **
6	29 × 68	422		0.214	4.70 **
7	29 × 68	4		0.002	405.98 **
8	89 x 68	585		0.097	28.20 **
		84	501		
		Scheme	Observant of		
9	5 x 68	180		0.529	0.48 Not a function
	187136	39098		0.209	40.74 **

* D statistically at (0.05) * D statistically at (0.01)

The above table shows that:

The average level of writing of the third level students for the elements of the analysis card was below average. There were statistically significant differences (0.01) between the average of the total writing ratio of the students and the value (0.50) which indicates 50% of the writing grade that the students are supposed to do. The table shows that although there are statistically significant differences (at level 0.01) between the average female writing ratio of the element (1) writing or representing the concepts and mathematical terms used in mathematical questions in terms of symbols or specific examples or drawings. This means that the level of student writing for this component is higher than average. Further, there are no statistically significant differences between the average female notation value ratios (0.50). In the element (9), summary of ideas and procedures: through brochures - charts - the classification and comparison of similar mathematical concepts and terms and identify the most important laws and procedures used and recorded notes for common errors, which indicates elements (6, 7, 8)and the level of students' writing is medium. The average number of female students is below the average level, which is the number (2, 3, 4, 5, 6, 7, 8). The element(2) describes and interprets mathematical relationships and ideas contained in questions incorrect mathematical language; (3) uses appropriate terminologies when solving mathematical questions; (4) Clarifies the mathematical generalizations used when solving mathematical questions; (5) Justifies or critiques answers with symbolic evidence or Analytical, or counter-examples when solving mathematical issues;(7) clarifies errors in the solution and writes the correction required, (8) stands for the use of her own language to write notes on mathematical concepts and procedures, and to distinguish important points. The average number of students' enrollment rates was very close to zero, indicating the lack of level of Intermediate level three writing for these elements.

Discussion

The researcher considers that the element (1) of the mathematical writing card, which achieved a higher percentage than the average, is one of the procedures for solving the basic exercises. So it appeared positively in the writings of the students.

The results of the analysis show that most of the students' writings were limited to writing the final result or writing simple steps of sums when writing in the student's book. When using the small posters, the few female students write the laws and sequence of steps, and the result shows that the writings are mostly inaccurate, with weak use of the appropriate linkage words in the sequence of the steps of the solution and between the two ends of the equations and some solutions wrong, with the absence of description and justification and generalizations in the writings of students. The researcher explains that it may be because the teachers are still practicing the role based on the teacher, where the teacher solves the exercises and provides explanation, description, and justification of the students and verbally, and involves students mostly in oral communication. The researcher further explains the reason for the weakness of the students' writing to solve the exercises of higher thinking skills. It is the lack of interest in the teachers to solve these exercises, believing that they concentrate on outstanding students and not weak students. In addition to their belief that the level of female students is weak and that the required content is not proportional to the number of classes, so it is not exposed to this type of exercise except very simple. The researcher found that most exercises of higher thinking skills are solved only by the question of error detection. The identification of error without analysis or interpretation, and most of the exercises associated with the reality of life has not been solved in most books, and this indicates the lack of interest by teachers to provide.

As for the elements (7, 8) which appeared low, the researcher finds that it is one of the writings that appear in the practice of the teachers for the formative evaluation, and its lack of interpretation is explained by weakness in the follow-up of female students and lack of interest in providing effective feedback. The teachers use the evaluation process. The results of the analysis showed that there was a correspondence in the students' writings, indicating that the answers were from the blackboard. The researcher also noticed a correction of the teachers on the answers of their students in the textbook (by using a

correct mark), although there are some answers and steps; faulty links; no explanations, suggesting that the correction is routine and did not aim to provide effective feedback (Thompson, 2010), that showed that teachers show little interest in the writings of learners and do not provide deep comments or provide concise and objective assessment.

The researcher explains the reason why do the students have average performance in the element (summarizing ideas and procedures through brochures - charts). The researcher, through the analysis, found that the students provided a summary in the brochures was only a summary of the rule and example of the rule and there is no correction of errors and noted the existence of a set of hands out with summaries in printed forms. It is clear that it is prepared by teachers and distributed to female students. The researcher believes that this is a sign of unconsciousness and unqualified objectives and components of their importance and crumpled them. These results are consistent with the results of the study of (Fried & Amit, 2003;Pugalee, 2004; Evens &Houssart, 2004; Meletiou-Mavrotheris&Paparistodemou, 2015), which showed that students often participated in the writing of mathematics involving copying or rephrasing instead of explaining new ideas. The most of the justifications they provided were incorrect or incomplete, and that priority was given to procedural education, while the opportunities for conceptual learning and the exploration of their learning processes and mathematical thinking were few.

Question 2: What is the level of mathematical thinking among third level students in Riyadh?

To answer this question, calculate the average mathematical thinking by using the T-test for the single sample to calculate the difference between the average mathematical thinking and the value that indicates 50% of the total score of mathematical thinking.

Table 6: The results of the test (T) for the single sample to indicate the difference between the average mathematical thinking and the value that indicates 50% of the total score of mathematical thinking among the third-grade students average (n = 70)

Variable	The average of the grades	Standard Deviation	50% of the total grade of the scale	Value (T)
Total score	12.14	4.05	16	7.97 **

* D statistically at (0.01)

In the previous table, there is a statistically significant difference (at 0.01) between the mean scores of the average third grade students in the total score of mathematical thinking (12.14) and the value (16 degrees), which refers to 50% of the total score of mathematical thinking, % of total grade. This result indicates that the average grade of third-level students in mathematical thinking is below average.

The following table shows the level of the students' scores on all the questions of the mathematical thinking scale

Table 7: Average grade of the third level students on the questions of the test of mathematical thinking

Question	1	2	3	4	5	6	7	8
Average	0.94	0.87	1.34	2.15	2.46	1.69	1.29	1.40

It is clear from the above table that all the questions of the scale achieved below-average scores, which is illustrated by the low level of most mathematical thinking skills except for the questions (5). The results of the analysis showed that most of the students' responses were stopped when determining the type of triangle only, without giving a description or clarification of the procedures. Question No. (5) required the opinions about the similarity of sides of opposite triangles. And the students failed to give proper explanation, and justification.

Although the rest of the questions of the scale showed a mediocre result, Question No. (1), which sought to solve the question, Question No. (2), which requested the solution, explaining the steps of the solution and justification of the result, achieved the lowest score.

Discussion

The results of the second question showed a decrease in the overall mathematical thinking of the students in the study sample. The results showed weakness in the description of the relations and their interpretation and naming of the concepts. There is a requirement of cognitive knowledge building and an important base for conceptual comprehension. The researcher noted that the students during their solution focused on reaching the output through the application of routine procedures without delving deep into the appropriateness of the law used for the mathematical concept. The researcher explained that it may be due to the fact that students may not be trained during the educational process, as the attention of the teachers lingered on the procedures and the solution to solve and not to the in-depth conceptual knowledge necessary for the students.

The results of the study also showed a weakness in the ability of female students to translate verbal questions and express them with symbols. The steps to solve the problems were not clear and disjointed, such as writing the resulting students without

clarifying the steps. Although there are steps; the left and right sides are not defined. Conducting steps for mathematical sums, then follow-up the solution, as well as an explanation of the mathematical relations contained in the text, are also not up to the mark.

The results also revealed a weakness in the skill of justification and the ability of students to describe the relationships and ideas included in the question. In addition to this, there is a weakness in the analysis and evaluation of the solution and to provide and justify the reason for choosing a specific answer correctly. The results of the study also showed that although the students have knowledge of the solution, they do not have the ability to write the solution correctly, and this is clear from the existence of phrases unfinished.

The researcher also found that although the questions (4, 5) were obtained at the intermediate level, two of the basic questions repeatedly used for their association with the basic laws and procedures in the properties of triangles and angles. However, the results showed a lack of symbolic expression, justification, and conclusion.

The researcher believes that this may be due to the lack of involvement of female students in the educational process to determine the final answer. They may try to explain the procedures, write justification and discuss without attention, simply showing their way of thinking. In addition to that, the researcher noted through previous research, to provide objective tests that depend on the role of the student to determine the correct answer, which may affect the ability of the student to solve the issues correctly, and this result is consistent with the studies that addressed the requirements and level of mathematical thinking, such as study done by (NCES, 2004; Hamada, 2006; Al Hashemi, 2010).

Question 3: What is the level of writing the third level students in their records about the level of their mathematical thinking?

To answer this question, the Pearson correlation coefficient was calculated between the level of writing of the third level students in their records and the level of their mathematical thinking. The results were as follows:

Table 10: Pearson correlation coefficient between the level of writing the third-grade students in their records and the level of their mathematical thinking (n = 66)

Variable	Level of writing students	
	Coefficient of correlation	Level of significance
The overall degree of mathematical thinking	0.971	0.01

In the above table, there is a statistically significant correlation (at level 0.01) between the level of writing of the third level students in their records and the level of their mathematical thinking. This means to a high or low extent, the student's score in mathematical thinking in mathematical writing can't be appreciated.

The results of the study in the first and second questions showed a weakness in the skill of mathematical writing in their records, as well as a poor level of mathematical thinking.

Discussion of results

The researcher found that the result of the third question of the correlation between the level of mathematical writing in the records and the level of mathematical thinking can be explained by observing the results of the level of written communication achieved at low rates which are almost nonexistent: description and interpretation of mathematical relations and ideas involved in mathematical issues, correcting the answers or critiquing them with symbolic or analytical evidence, or with counter-examples when solving mathematical questions; explaining errors in the solution and writing the answers, which means that female students throughout the semester were not directed to take care of these procedures, which are directly related to the skills of mathematical thinking. The absence of analysis, evaluation, description, and interpretation from the female students' records reveals a weakness in their ability. The students did not exercise the basic requirements of the skill of mathematical thinking through writing, which may have a significant effect on the level of their thinking.

Moreover, the results of the second question showed a very weak level of female students they used very less number of words in the steps of solving sums, which indicates the weakness of the students in the verbal problems.

The researcher sees through the analysis of the records and finds that there is absence of guidance in the classroom practices to take care of active mathematical writing that trains female students to practice mathematical thinking and allows students to explain, justify, interpret and organize their mathematical writings to help them to know their mistakes and modify them. As a result, students can't acquire the skills of thinking. Moreover, verbal communication with simple answers to the questions asked by the female students is often directed by the teacher. The teachers are only able to explain and record the procedures themselves on the blackboard. In the absence of a proper follow-up of female students' in their records, the students lose a lot of basic skills for the development of mathematical thinking.

This is consistent with the studies that emphasized that the practice of mathematical communication in the notebook has a therapeutic role that has an impact on the acquisition of mathematical concepts, mathematical thinking (Thompson,2010; Santos&Semana,2015).

CONCLUSION

Through the results of the study, regarding the weakness of mathematical writing and mathematical thinking among the female students, the researcher sees the need to take appropriate action to develop mathematical writing, by reducing the teacher's control over the entire educational process, and make learning centered on the learner, and help learners to build their own mathematical knowledge and to consider the activities of mathematical writing in all its components as a tool for the development of mathematical thinking, so that the writing is kept in a special book in which the elements of mathematical writing are applied continuously and purposefully throughout the year.

As well as, there is need of constant educated guidance to determine the terminology to formulate vocabulary when teaching new concepts and to encourage them to write definitions in their own language, to represent concepts in more than one form, to write their own learning strategies, to increase their awareness of these concepts and their relationships and to reflect on their solutions. With an emphasis on the need to take into account logical sequence in the steps of the solution, write the correct links, explain and justify their conclusions, and provide accurate feedback on the integrity of mathematical writing. Teachers should encourage them to discuss ideas after writing in their notebooks and discuss their mistakes and justification in small learning groups for the accuracy of the interpretation or justification.

LIMITATION AND STUDY FORWARD

The objective limits of this study are the mathematical writing based on mathematical thinking among the third level female students. Also, the spatial boundaries are determined by the selected schools in Riyadh City for the academic year H 1438 - 1439. Further, studies may be conducted to determine the relationship between the levels of mathematical writing with other important teaching practices.

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